

CLAIMS

1. In a method adapted to provide a pressurized gas stream useful for removing nitrogen oxides from a combustion gas stream by SNCR (Selective Non-Catalytic Reduction), or SCR (Selective Catalytic Reduction), the improvement which comprises:

a) establishing an aqueous solution of urea or mixtures of urea containing biuret and/or ammonium carbamate, and hydrolyzing the urea therein at temperatures and pressures sufficient to produce a gaseous product stream of ammonia, carbon dioxide and water at a rate sufficient for external use in step d), and a residual liquid phase reaction medium containing unreacted urea, biuret and/or ammonium carbamate;

b) separating the gaseous product stream at a controlled pressure and flow rate;

c) retaining the liquid phase reaction medium in the reactor for further conversion to gaseous ammonia and carbon dioxide, and/or recycling at least a portion of the reaction medium back into the reactor, a urea dissolver, or the feed solution to the reactor for further conversion; and

d) withdrawing the gaseous ammonia and carbon dioxide-containing product stream and feeding it for external use at a controlled rate which is approximately the amount necessary to the demands of said external use in removing said nitrogen oxides.

2. The method of claim 1 wherein the aqueous solution contains weight of solids about 1% to 76%.

3. The method of Claim 1-Step a) in which the gaseous products of the hydrolysis reaction and the liquid reaction media are withdrawn from the reactor as a mixed

gas and liquid stream; following which

a) The gaseous ammonia and carbon dioxide products formed are separated from the liquid reaction media while under the operating pressure in a separation device;

b) Recycling the liquid phase reaction media from the separation device back into the reaction media, urea dissolver, or urea feed solution for further conversion of unreacted urea, biuret and intermediate ammonium carbamate therein; and

c) Withdrawing the gaseous ammonia and carbon dioxide product formed in Step a) for an external use at said controlled rate.

4. The method of claim 1 in which the hydrolysis reaction is carried out under non-catalytic conditions and the rate of production of ammonia is controlled thermally and by the quantity of solution in the reactor.

5. The method of Claim 1 in which the reaction rate to form the gaseous ammonia-containing product is enhanced by inclusion in the reaction media of a composition which increases the rate of the hydrolysis of urea and biuret and is selected from the following:

a) Oxides or ammonium or alkali metal salts or hydroxides of elements in Groups III-B, IV, V and VI-A of the Periodic Chart Of The Elements, or the hydroxides, carbonates or bicarbonates of Group I;

b) Ion-exchange resins of the acidic or basic types, and

c) Activated carbon, silica or alumina.

6. The method of claim 1 wherein the liquid contents of the reactor is held at an essentially constant volume.

7. The method of Claim 1 wherein said concentration range is from about 10% to 76% solids.

8. The method of Claim 1 in which the conditions of operation are carried out within the temperature range of about 110°C to about 300°C and pressure range of about 20 PSIG to about 500 PSIG.

9. The method of Claim 1 in which the gaseous ammonia and carbon dioxide product being discharged are maintained at a temperature above 60°C.

10. The method of Claim 1 in which said external use of the ammonia in the product ammonia and carbon dioxide produced is for removing nitrogen oxides from combustion gas streams by SNCR (Selective Non-Catalytic Reduction or SCR (Selective Catalytic Reduction) processes.

11. The method of Claim 1 in which said external use of ammonia in the gaseous product ammonia and carbon dioxide produced is for the removing particulate matter from combustion gas streams by conditioning the particulate matter for improved removal by electrostatic precipitators or fabric filters.

12. The method of Claim 1 in which a portion of the water vapor in the ammonia and carbon dioxide product stream leaving the reactor is removed by cooling the product gas stream in a condenser while under pressure.

13. The method of Claim 12 in which the water removed from the gaseous ammonia and carbon dioxide gaseous product stream is recovered and recycled back to the hydrolysis reactor or used to replace water used in the preparation of the urea feed solution.

14. The method of Claim 12 in which the urea feed solution is used as the coolant to the condenser, following which the heated solution is delivered to the hydrolysis reactor.

15. The method of Claim 12 in which the pressure within the reactor is monitored and controlled by the gas phase pressure, and gas phase pressure gauge, control valve and connection lines are provided and are heated to above 60°C.

16. The method of Claim 15 in which the pressure within the reactor is monitored and controlled by the liquid phase pressure, the pressure gauge and connection line being at a temperature from ambient to the temperature of the reactor solution.

17. The method of Claim 1 in which an emergency pressure relief valve is connected to a tank containing water, said tank containing sufficient cold water to cool the reactor solution discharge to stop the hydrolysis process.

18. The method of Claim 10 in which a reactor discharge control valve is provided and is regulated to provide a controlled flow rate of the gaseous ammonia and carbon dioxide product stream which matches the amount of nitrogen oxides in said combustion gas streams.

19. The method of Claim 11 in which said reactor discharge control valve is regulated to provide a controlled flow rate of the gaseous ammonia and carbon dioxide product stream for conditioning the combustion gas to provide improved collection of particulate matter in said combustion gas streams.

20. The method of Claim 1 in which the product ammonia and carbon dioxide gas stream is mixed with a dilution gas, said dilution gas being comprised of air, steam or flue gas, or mixtures thereof, prior to said external use.

21. The method of Claim 10 in which the heat required for the hydrolysis reaction is derived from said hot combustion gas streams.

22. The method of Claim 20 in which the dilution gas is heated prior to said external use.

23. A method for producing a gaseous ammonia-containing product from urea, or mixtures of urea containing biuret and/or ammonium carbamate, said ammonia-containing product being essentially free of urea, biuret, or ammonium

carbamate, the process comprising;

a) establishing an aqueous solution of urea or mixtures of urea containing biuret and/or ammonium carbamate, and hydrolyzing the urea therein at temperatures and pressures sufficient to produce a gaseous product stream of ammonia, carbon dioxide and water at a rate sufficient for external use in step d), and a residual liquid phase reaction medium containing unreacted urea, biuret and/or ammonium carbamate;

b) separating the gaseous product stream at a controlled pressure and flow rate while maintaining its temperature above 60°C.;

c) retaining the liquid phase reaction medium in the reactor for further conversion to gaseous ammonia and carbon dioxide, and/or recycling at least a portion of the reaction medium back into the reactor, a urea dissolver, or the feed solution to the reactor for further conversion; and

d) withdrawing the gaseous ammonia containing product stream and feeding it, while maintaining its temperature above 60°C, at a controlled pressure and rate of flow for said external use.

24. A method for producing a gaseous ammonia-containing product from urea, or mixtures of urea containing biuret and/or ammonium carbamate, said ammonia-containing product being essentially free of urea, biuret, or ammonium carbamate, the process comprising;

a) establishing an aqueous solution of urea or mixtures of urea containing biuret and/or ammonium carbamate, and hydrolyzing the urea therein at temperatures and

pressures sufficient to produce a gaseous product stream of ammonia, carbon dioxide and water at a rate sufficient for external use in step d), and a residual liquid phase reaction medium containing unreacted urea, biuret and/or ammonium carbamate;

b) separating the gaseous product stream at a controlled pressure and flow rate while maintaining its temperature above 60°C.;

c) retaining the liquid phase reaction medium in the reactor for further conversion to gaseous ammonia and carbon dioxide, and/or recycling at least a portion of the reaction medium back into the reactor, a urea dissolver, or the feed solution to the reactor for further conversion; and

d) withdrawing the gaseous ammonia and carbon dioxide-containing product stream and feeding it, while maintaining its temperature above 60°C, for external use at a controlled pressure and controlled rate which is approximately the amount necessary to meet the demands of said external use.